RISK ASSESSEMENT OF CHEMICAL RESIDUES IN FOOD DETERMINED BY THE USE OF PESTICIDES IN AGRICULTURE

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Abstract
The issue of the potential risk of chemical residues arising from the use of plant protection products in agriculture on public health is widely discussed and is a real concern because of soil contamination in the first production phase - on farms, animal contamination by feed and then product contamination in the end. And the worst thing is that the presence of chemical residues is not listed on any label nor is it regulated by law. The present paper aims to analyze the effects of these substances on human health through a two-way approach regarding their degree of toxicity on the body and intake estimation that can produce negative effects in the metabolic processes. The purpose of this analysis is to identify what amount of chemical residue reaches the finished product following each stage of the agri-food chain.

Keywords
Chemical residues, food safety, pesticides

JEL Classification
Q10, I1, Q50, L66

Introduction

Agriculture, as a first branch of the contemporary economy, performs several essential functions while ensuring the necessary food for the entire population. Food security is a difficult task to achieve because of the seasonal nature of agriculture, climate change, and adverse weather conditions in many areas of the globe. To protect the vegetable crops that meet the demand worldwide, it is necessary to use different products that help fight diseases and pests and, on the other hand, increase the resistance of plants to external factors. Plant protection products (PPPs) have a beneficial effect on increasing yield in agriculture by helping to ensure food security. Still, it seems that their irresponsible use has an adverse impact on food safety. Once they reach the ground, on the surface of the plants or used in

animal husbandry, these artificial substances reach the agri-food chain, determining the presence of chemical residues in the finished product. Each stage of the agri-food chain tends to amplify the effects of these residues and to multiply their number by using different cleaning agents and additives. It is well known that food contaminated with chemical residues presents numerous hazards to human health even ingested in a small amount. The present research aims to determine the harmful effects of chemical residues in food due to the use of PPP and the different substances at each stage of the agri-food chain, emphasizing the risks for human consumption and offering alternatives for reducing these risks.
Table no. 1 analyzes the potential chemical risks at each stage of the agri-food chain and provides an overview of all residues that may reach the final product, on the table of consumers.

Table no. 1 Potentially Chemical Risks in each stage of agri-food chain

AGRO-FOOD CHAIN STAGES	CHEMICAL RESIDUES IN VEGETABLE PRODUCTS	CHEMICAL RESIDUES IN ANIMAL PRODUCTS
PRODUCTION PHASE	Pesticides, PPPs, pollutants, mycotoxins, fertilizers	Antibiotics, growth hormones, detergents, pesticides from feed.
PROCESSING PHASE	Surface cleaning angles, detergents, additives, chemical residues caused by poor air circulation, contamination with chemical residues due to incorrectly trained personnel, chemical residues on the contact surfaces	Medicinal treatments, detergents, pesticides arising from the use of aromatic plants, chemical residues caused by poor air circulation, contamination with chemical residues due to incorrectly trained personnel
TRANSPORT	environmental pollutants, detergents, freon, fuels, chemical residues on the contact surfaces	environmental pollutants, detergents, freon, fuels, chemical residues on the contact surfaces
COMMERCIALIZATION	chemical contaminants used in stores, chemical contaminants resulting from reaching the products unpacked by the customers, different types of wax, surface pollutants, detergents, chemical residues from the atmosphere	detergents, surface polluting agents, chemical contaminants used in stores, chemical residues from the atmosphere

Source: Personal processing based on data provided by S Mortimore, C Wallace – 2013
age of the agri-food chain

The identification of potential risks at each stage of the agri-food chain is indispensable and is not lacking as a principle from any management system (such as the HACCP Hazard Analysis system in Critical Control Points) of the production, processing or marketing units and is real. To find preventive and corrective measures that will lead to the proper functioning

of the processing unit and to minimize the risks, thus ensuring high-quality products, fresh and uncontaminated. To ensure food safety, a very well-trained staff that respects the rules of the unit is needed, and an equipped unit is necessary to avoid contamination of food due to poor air circulation or the penetration of pollutants from the atmosphere. Also, the technical-material parameters must be strictly observed, and continuous monitoring throughout the agri-food chain is an essential factor in ensuring food safety. The use of selective breeding techniques, fertilizers, herbicides, and fungicides in agriculture has increased the efficiency of food production dramatically. These modern production methods have reduced costs and increased the variety of foods available. Because food production is so complex, a systematic approach is needed to identify potential risks at each point in the production chain so that food poisoning and food contamination are avoided. The presence of pesticide residues is a cause for concern for consumers because pesticides are known to have potentially harmful effects on other non-target organisms other than pests and pathogens. The primary concerns are their toxic effects, such as affecting the reproductive system and the development of the fetus, as well as their ability to cause cancer and asthma. Because of the toxic action that public opinion believes that all pesticides and plant protection products (PPPs) have, they are considered extremely harmful substances that can have adverse effects on human health and the environment. The responsible use of these artificially synthesized chemicals involves the use of quantities below the maximum permitted limit (MRL) legally regulated by the European Commission by Regulation (EU) 2020/421 of 18 March 2020. Pesticides are often required for both agriculture and economy in general because of the destruction of crops by diseases or pests that, in the absence of effective methods of control, produce devastating effects, economic losses also occur at harvesting. Organic farming cannot provide the necessary food supply to cover the demand of the population, and the agricultural producers consider that these protection plant products are indispensable. When assessing the risk and adverse effects on human consumption of pesticide residues and the presence of these substances in agri-food products, consideration must be given to meeting the demand of the ever-growing population of the world and to ensuring safe food for consumption, accessible as a price and availability, and nutritious rich. The efforts of the bodies empowered in Romania and the European Union to protect food safety and food security from the point of view of the presence of pesticide residues and of the risk they pose for health, translate into regular and rigorous monitoring, which must be objectively interpreted to draw conclusions correct and in accordance with the scientific reality.

The maximum level of pesticide residues provides a standard by which it can be verified that the foods that have included the use of pesticides in the technological process are safe for human consumption. The mere fact that there are pesticide residues in food does not mean that they are automatically harmful to health. The maximum accepted residue level to be ingested every day, the whole life is calculated by applying a safety factor at least 100 times lower than the dose at which possible harmful effects of the active substance on human health could be detected. In the European Union, these standards are set by the European Crop Protection Association (ECPA) following consultation between the European Food Safety Authority (EFSA) and the Member States. At a national level, an annual monitoring program for pesticide residues from plants and plant products, from domestic production, is being carried out under the supervision of the National Phytosanitary Authority (ANF). According to the report (* report on the national plan for monitoring residues of pesticides from fruit, vegetables, and grains from internal production, for the year 2016 (following Regulation (EC) no 396/2005)) published in January 2017 by ANF, the following results were obtained:

- of the 1026 fruit and vegetable samples analyzed, 1013 samples were compliant, and 13 samples were non-compliant, representing 1% (1 potato, 1 parsley leaf, 5 salad samples, 1 strawberry sample, 1 peach, 4 apple samples);

- of the 683 vegetable samples, 193 (28%) showed pesticide residues, and except for 7 samples that showed pesticide residue values above the maximum permitted limits, the rest of the samples were below the maximum level of safety;
- of the 343 fruit samples, 167 showed pesticide residues below the maximum level of safety, and 6 samples showed residue values above the maximum permitted limits

The risks associated with the use of pesticides in agriculture appear to be insufficient and are suppressed by the negative effects of these substances on human consumption. Because the use of pesticides is not always well planned, with the fight against diseases and pests, negative effects on the biodiversity of plants and animals, on the groundwater and on the terrestrial ecosystems, are seen. According to Majewski and Capel (1995), about 80–90% of the applied pesticides in open field crops can be volatilized within a few days of application (Majewski and Capel 1995). Straathoff also states that spray herbicides that are applied to the leaves of plants and contain volatilized substances are very dangerous and thus end up destroying beneficial plants and contaminating the soil (Straathoff 1986). Worldwide it has been found that endangered species of birds and rodents are greatly affected by the irresponsible use of plant protection products (PPPs) in agriculture and the use of growth agents for both crop and animal husbandry. According to the level of toxicity presented by pesticides, it seems that insecticides are the most toxic substances followed by products designed to fight fungus (fungicide) and herbicides.

The most commonly used pesticides include:

- metolachlor-S is an effective herbicide against grasses;
- glyphosate is an herbicide used to kill weeds and grasses;
- atrazine is also an herbicide used to kill grassy and broadleaf weeds;
- 2,4-D is an herbicide used to kill broadleaf weeds;
- dichloropropene can treat the soil before planting to kill roundworms.

Pesticides can penetrate and contaminate the environment in two ways. If it is used as a water-soluble pesticide that enters the groundwater, in rivers, and cause devastating effects on water and soil quality and, on the other hand, fat-soluble pesticides which are ingesting the contaminated feeds reach into the fatty tissues of the animals and then into the entire chain of production, processing, and marketing of agri-food products, implicitly in human nutrition.

The process of Bioamplification of pesticides in the environment along the food chain starts from contaminating plants with chemically synthesized substances (pesticides). The small ingestion amounts by primary consumers of the food chain, such as grasshoppers or other insects to be eaten by secondary consumers such as small birds and rodents, which in turn are consumed by larger birds or prey animals and thus in their body the amount and spread of ingested pesticide increases. Therefore, the higher the temperature, the greater will be the pesticide concentration, which is known as bioamplification. In agriculture, the process is similar and begins in the production phase (on the farm) where the pesticides used irresponsibly reach the feed of animals that are then slaughtered to cover the demand for meat on the market and become consumed by humans.

The path that pesticides and plant protection products follow to determine chemical residues in the finished product begins in the production phase (on the farm) when different chemicals are applied to crops to protect them from external factors, diseases and pests and strengthen their resistance. The study of the traceability of agri-food products creates an overview on the possibility of food contamination in each phase of processing with different inorganic compounds that negatively influence the quality and safety of the finished product, finding the form of chemical residue. The route of the agri-food chain and the identification of the main potential risks of a chemical nature are highlighted in Fig. no. 1.

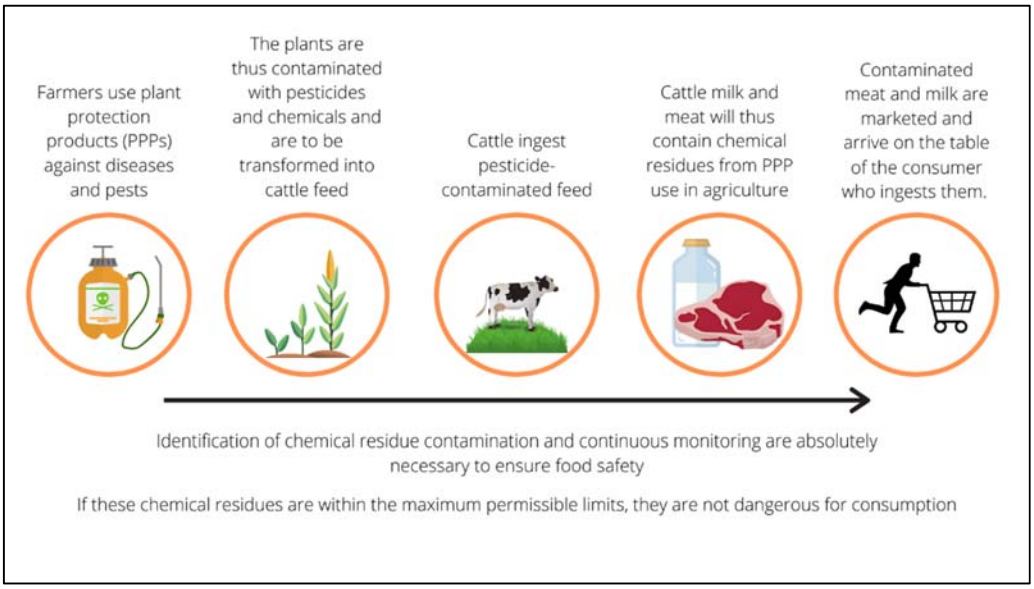

Fig. no. 1 Monitoring of the beef and dairy production chain - Contamination of finished products with chemical residues from pesticides
Source: Alina Stancu, Radu Antohe, 2019. Food Safety Assessment And The Contaminant Chemical Residues, IAE, Belgrade

According to a study held by some specialist in nutrition from University of California, San Francisco, in 2017 the fruits and vegetables with the highest level of pesticides are: strawberries, spinach, grapes, kale, apples, nectarines, celery, peaches, pears and tomatoes, and the fruits and vegetables with the lowest level of pesticides are: papaya, avocado, frozen peas, onion, sweetcorn, broccoli, kiwi, mushrooms, asparagus, and eggplant.
In order not to pollute the environment with pesticide residues and to avoid any problems in trade relations with EU countries, the fate of pesticides after use must be well known. In developed countries, the analysis of pesticide residues began in 1950.
These analyzes are performed in laboratories accredited by the competent Accreditation Agency. In these studies, both the legal regulations and the standards published by the national and international organizations are respected. When exporting agricultural products to foreign countries, these products must not contain chemical residues. Therefore, especially after the 1990s, residue analysis has been an important parameter in quality control and quality assurance studies. If pesticide residues are found, especially in agricultural products shipped to Europe, they are immediately notified. Therefore, the reliability and accuracy of pesticide residue analysis data should be checked by quality systems. The accreditation authority of the laboratories carrying out the residue analysis is therefore requested. Accreditation is the approval of an accreditation body that this laboratory is sufficient to perform certain analyzes.The scope of food residue analysis is quite wide. For example, the main residue analyzes are: analysis of naphthalene in honey, analysis of pesticides in fruits and vegetables, determination of benomyl and carbendazim in fruits, vegetables, legumes and cereals, determination of residues of benzimidazole in milk, analysis of pesticides in fatty foods, benzo (A) pyrene (PAH) in olive oil. Determination, analysis of pesticides in feed samples

Conclusions

Over time, pesticides have proven to be almost indispensable for farmers around the world, due to their efficiency in combating diseases and pests, increasing production, and thus bringing countless benefits to the economy and society. In developing countries, the use of plant protection products, including pesticides in conventional agriculture, cannot be replaced by eco-friendly alternatives such as using natural oils instead of insecticides, attracting small birds, and feeding rodents. With crop pests because these methods require additional costs and cannot ensure continuous and sufficient production to cover food security.

The very small subsidies offered by the state to the farmers cannot cover the expenses with all these natural methods so that organic agriculture will spread in all areas of the world and the seasonal character of the agriculture, as well as the increasingly unpredictable weather conditions of the last time, make the vegetable crops more susceptible to climate change, to develop diseases and pests that can often be controlled only with pesticides. The main objective of the present research is delimited around the identification of the advantages and disadvantages that conventional agriculture and organic agriculture bring to the environment and are presented in Fig. no. 2.

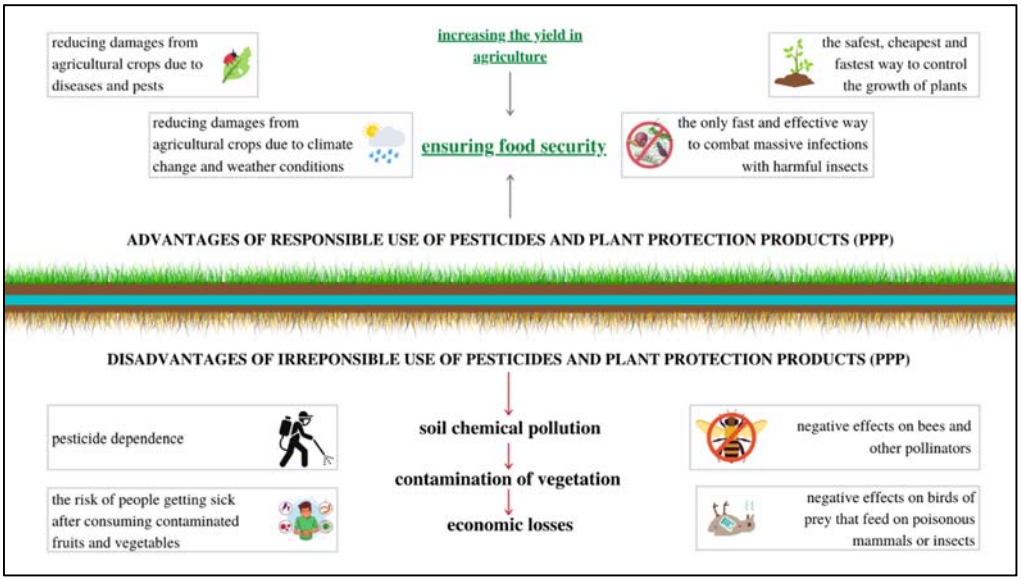

Fig. no. 2 Advantages & Disadvantages of pesticide use in agriculture

Source: Personal processing

Despite all the benefits of pesticides, many adverse effects on the environment and human health have been proven. Their irresponsible use causes contamination of plants, animals, and the environment, and all of these effects affect the human race. Worldwide, effective solutions have been found to minimize the risks of pesticide use, from changing formulas to more natural and not so toxic ones to banning some substances from the market. Also, the legislative norms envisage the responsible use of PPP in imposing the maximum allowed limits, which, if they were respected, would diminish the adverse effects.

In the future, less toxic chemical pesticides can be used in combination with eco-friendly treatments as natural oils and powders or natural remedies that result in more sustainable elimination of pests and insects. This combination promises not only environmental sustainability but also has different applications in controlling urban pests and invasive species (Gentz et al. 2010).

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